CHROMOSOME NUMBERS OF CLAYTONIA VIRGINICA IN THE ST. LOUIS, MISSOURI AREA

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ABSTRACT

Chromosome numbers of $2n$ = 22, 23, 24, 25, 26, 27, 29, 30, 31, 32, 33, 34, 35, 36, and 37 are reported for *Claytonia virginica* L. from the St. Louis, Missouri area. Those plants with $2n$ = 24 and 30 are by far the most frequent. Morphologically the species separates into two groups: plants having narrow leaves which are characteristic of the lower polyploid cytotypes, and those having broad leaves which are typical of the higher polyploid races.

The widespread diversity of chromosome numbers from $2n$ = 12 to 191 is well documented for the portulacaceous species *Claytonia virginica* L. (Rothwell, 1959; Rothwell & Kump, 1965; Lewis, 1967; Lewis et al., 1967), although the study of many plants from a single area has only been attempted in eastern Texas (Lewis, 1962). The purpose of this research was to learn what chromosomal and morphological diversity existed for *C. virginica* in the St. Louis area.

During the spring months of 1966 and 1967, flower buds were removed from plants of 28 populations in St. Louis and St. Louis County. Pollen mother cell meiosis was observed for 175 plants, a sample considered large enough to illustrate diverse trends in the species if indeed they existed in the area. Cytological procedures followed those of Lewis (1962) and voucher specimens for each population were collected and are housed in the Missouri Botanical Garden herbarium (MO).

RESULTS AND DISCUSSION

Below are listed the chromosome numbers found for varying numbers of plants sampled at random from the 28 populations. The exact locality for each population is given together with the diploid number of plants (frequency in parenthesis) and the meiotic configurations generally at metaphase I or more rarely at anaphase I or metaphase II. Occasionally a count was confirmed by somatic divisions, but these are not indicated. Only two plants were found to be aneusomatic, i.e. with chromosome number varying intra-individually (Lewis, 1962); apart from their listing below and notation in Fig. 1, these plants will not be considered further.

A. St. Louis Co, 380 St Louis St, Florissant, *Suda 12:* **2n** = **30**(6), **31**(3), **33**(1)—6 plants 15_{II}, 3 plants $15_{II}+1_{I}$, 1 plant $16_{II}+1_{I}$. [1967]

B. St Louis Co, nr jct of Old Halls Ferry Rd & Parker Rd., Black Jack, *Suda 16:* **2n** = **30**(5), **31**(3), **32**(1), **33**(1)—5 plants 15_{II}, 3 plants $15_{II}+1_{I}$, 1 plant 16_{II}, 1 plant $16_{II}+1_{I}$. [1967]

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C. St. Louis Co, 1370 Criterion Ave, Spanish Lake, *Suda 11:* **2n = 24**(5), **30**(1), **34**(1)—5 plants 12_{II}, 1 plant $12_{II}+6_{I}$, 1 plant 17_{II}. [1967]

D. St Louis Co, jct of Estelle Ave & Harvey Ave, Ferguson, *Suda 13:* **2n = 24**(1), **25**(2), **26**(7)—1 plant 12_{II}, 2 plants $12_{II}+1_{I}$, 1 plant $11_{II}+4_{I}$, 3 plants $12_{II}+2_{I}$, 3 plants 13_{II}. [1967]

E. St. Louis Co, 10045 Viscount Dr, Moline Acres, *Suda 9:* **2n = 30**(6), **31**(4)—6 plants 15_{II}, 4 plants $15_{II}+1_{I}$. [1967]

F. St Louis Co, 208 Midlothian Rd, Larimore, *Suda 10:* **2n = 22**(8), **23**(2)—8 plants 11_{II}, 2 plants $11_{II}+1_{I}$. [1967]

G. St Louis Co, 3529 Calvert Ave, St John, *Suda 14:* **2n = 30**(4)—4 plants 15_{II}. [1967]

H. St Louis Co, 3724 Avondale Ave, Arbor Terrace, *Suda 15:* **2n = 24**(2), **25**(2), **26**(1), **27**(1), **29**(1), **30**(2), **32**(1)—2 plants 12_{II}, 2 plants $12_{II}+1_{I}$, 1 plant 13_{II}, 1 plant $13_{II}+1_{I}$, 1 plant $12_{II}+5_{I}$, 1 plant $12_{II}+6_{I}$, 1 plant $1_{IV}+10_{II}+6_{I}$, 1 plant $12_{II}+8_{I}$. [1967]

I. St Louis, Terminal RR betw W Florissant & Bdwy, *Lewis 6607:* **2n = 24**(1)—1 plant 12_{II}. [1966]

J. St Louis, nr Mark Twain Expressway, O'Fallon Pk, *MacBryde 23:* **2n = 30**(2), **32**(1), **35**(1)—1 plant 15_{II}, 1 plant 15_{II} & $14_{II}+2_{I}$, 1 plant $15_{II}+2_{I}$, 1 plant $16_{II}+3_{I}$. [1966]

K. St Louis Co, 12824 Ladue Rd, *MacBryde 18:* **2n = 22**(1), **23**(3), **24**(1)—1 plant 11_{II}, 3 plants $11_{II}+1_{I}$, 1 plant 12_{II}. [1966]

L. St Louis Co, Ladue Rd, 0.7 mi W of Price Rd, Ladue, *MacBryde 15:* **2n = 30**(2), **31**(1), **32**(2)—1 plant $14_{II}+2_{I}$, 1 plant 15_{II}, 1 plant $15_{II}+1_{I}$, 2 plants 16_{II}. [1966]

M. St Louis Co, John Burroughs School, Ladue, *MacBryde 14:* **2n = 24**(2)—2 plants 12_{II}. [1966]

N. St Louis Co, 332 N Meramec Ave, Clayton, *MacBryde 17:* **2n = 30**(4)—4 plants 15_{II}. [1966]

O. St Louis Co, 601 S. Brentwood Blvd, Clayton, *MacBryde 9:* **2n = 23**(1), **24**(10), **25**(2), **26**(1), **30**(1), **23-25** (1, aneusomatic)—1 plant $11_{II}+1_{I}$, 10 plants 12_{II}, 2 plants $12_{II}+1_{I}$, 1 plant $12_{II}+2_{I}$, 1 plant $12_{II}+6_{I}$, 1 plant $11_{II}+1_{I}$ (2 cells), 12_{II} & 12+12 (9 cells) & 12_{II} & 1_{I} (2 cells). [1966, 1967]

P. St Louis Co, Oak Knoll Pk, Clayton, *MacBryde 10:* **2n = 24**(3)—3 plants 12_{II}. [1966]

Q. St Louis Co, Washington Univ campus, *Lewis 6688:* **2n = 29**(2), **30**(2), **32**(1), **36**(2)—2 plants $14_{II}+1_{I}$ (+0-1 fragment), 2 plants 15_{II}, 1 plant 16_{II}, 2 plants $17_{II}+2_{I}$. [1966]

R. St Louis Co, 6355 Pershing Ave, University City, *MacBryde 24:* **2n = 24**(13), **37**(2)—1 plant $11_{II}+2_{I}$, 12 plants 12_{II}, 1 plant $16_{II}+5_{I}$ & $18_{II}+1_{I}$, 1 plant $17_{II}+3_{I}$. [1966, 1967]

S. St Louis, betw St Louis Zoo & Art Museum, Forest Pk, *MacBryde 11:* **2n = 24**(4), **25**(2)—4 plants 12_{II}, 2 plants $12_{II}+1_{I}$. [1966]

T. St Louis, N of Jewel Box, Forest Pk, *MacBryde 22:* **2n = 24**(4)—4 plants 12_{II}. [1966]

U. St Louis Co, NW corner Rosalie Tilles Pk, Ladue, *MacBryde 16:* **2n = 24**(2)—2 plants 12_{II}. [1966]

V. St Louis, 7113 Arsenal St, *MacBryde 27:* **2n = 30**(1)—1 plant 15_{II}. [1966]

W. St Louis, Missouri Bot Gard. *Suda 17:* **2n = 30**(5), **31**(1), **32**(2), **33**(1), **34**(1)—1 plant $14_{II}+2_{I}$, 4 plants 15_{II}, 1 plant $15_{II}+1_{I}$, 2 plants 16_{II}, 1 plant $15_{II}+3_{I}$, 1 plant $16_{II}+2_{I}$. [1967]

X. St Louis Co, 0.1 mi NE of Barrett Sta Rd on Dougherty Ferry Rd, *MacBryde 19:* **2n = 30** (1)—1 plant 15_{II}. [1966]

Y. St Louis Co, 1.1 mi W of Geyer Rd on W Adams Ave, Kirkwood, *MacBryde 5:* **2n = 29**(1)—1 plant $14_{II}+1_{I}$. [1966]

Z. St Louis Co, 326 E. Jefferson Ave, Kirkwood, *MacBryde 20:* **2n = 24**(1)—1 plant 12_{II}. [1966]

AA. St Louis, 0.4 mi N of Pkwy Lane on River Des Peres Pkwy, *MacBryde 25:* **2n = 30**(4), **31**(4), **32**(4), **34**(1), **34-36**(1, aneusomatic)—4 plants 15_{II}, 3 plants $15_{II}+1_{I}$, 1 plant $15_{II}+1_{I}$ & $14_{II}+1_{III}$, 1 plant $15_{II}+2_{I}$, 3 plants 16_{II}, 1 plant 17_{II}, 1 aneusomatic plant $14_{II}+1_{IV}+1_{III}+1_{I}$, $15_{II}+1_{IV}+2_{I}$, $15_{II}+1_{III}+2_{I}$, $15_{II}+1_{III}+1_{I}$(+1 fragment), $16_{II}+2_{I}$(+1 fragment), $16_{II}+3_{I}$, $16_{II}+3_{I}$(+1 fragment), $16_{II}+1_{III}+1_{I}$ (minimum of one cell each). [1966, 1967]

BB. St Louis, River Des Peres Pkwy, 0.3 mi NW of Gravois Ave, *MacBryde 26:* **2n = 31**(2)—2 plants $15_{II}+1_{I}$. [1966]

As summarized geographically in Fig. 1, the chromosome numbers of *C. virginica* (with frequency in parenthesis) are $2n$ = 22(9), 23(6), 24(49), 25(8), 26(9), 27(1), 29(4), 30(46), 31(18), 32(12), 33(3), 34(3), 35(1), 36(2), and 37(2). The significant features of these data include: (1) by far the most common numbers found in this random sample are $2n$ = 24 and 30 with the majority of populations consisting of plants having chromosome numbers around either 24 or 30; (2) no distributional separation of cytotypes was noted, though only two populations (C, R) had plants of both major cytotypes based on maximum bivalent pairing; (3) except for univalent "formation" meiotic abnormality was infrequent (4) all plants examined were autopolyploids (cf. Lewis et al., 1967); and (5) frequency of polyploids does not represent a Gaussian curve, but rather a bimodal one with few plants having $2n$ = 27 and 29 and none with $2n$ = 28 (Fig. 2).

If univalents are eliminated in a consideration of chromosome number and only maximum bivalent pairing is used as a basis of number, then the frequency of those plants having 12_{II} and 15_{II} is greatly increased and the bimodal chromosomal curve is accentuated. This procedure is logical for the majority of plants with univalents were simply those having an unpaired chromosome; otherwise they usually exhibited normal meiosis. The univalent may or may not be associated with the haploid complement following meiosis, for often it was excluded during the process, or, if retained, then typically found in only one-half of the haploid nuclei. Based, therefore, only on bivalent formation, those having 12_{II} at metaphase I total 38.1% of the plants studied, those with 15_{II} total 35.3% or together about ¾ of all plants examined in the area. Of the remainder we found 11_{II} for 10% of the plants, 13_{II} for 3%, 14_{II} for 3%, 16_{II} for 8%, 17_{II} for 3% and 18_{II} for <1% as shown graphically in Fig. 2.

Of the 15 polyploid races found in the St. Louis area clearly those with $2n$ = 24 and 30, and more particularly plants with 12_{II} and 15_{II}, are in the majority. The cytotype with n = 12 is also the most widespread autotetraploid for *C. virginica* as a whole and is probably an old tetraploid race derived early from the diploid n = 6 which is now limited to the relict area of the southern Appalachians (Lewis et al., 1967). Although of much less frequency plants with 11_{II} (usually $2n$ = 22 and 23) total 10% of those studied; they are often found with plants having 12_{II} and probably represent those derived by chromosomal loss from the latter. Considered together plants with 11_{II} and 12_{II} account for about ½ of those examined, which emphasizes the significance of the x = 6 line at the tetraploid level in the St. Louis area.

Although plants with 15_{II} (usually $2n$ = 30 and 31) are known elsewhere within the ranges of the primary tetraploid line (x = 6, 7, 8), their frequency does not appear to be nearly as great as that found in the St. Louis area (35%). This situation may be due to limited mass sampling elsewhere rather than to a unique-

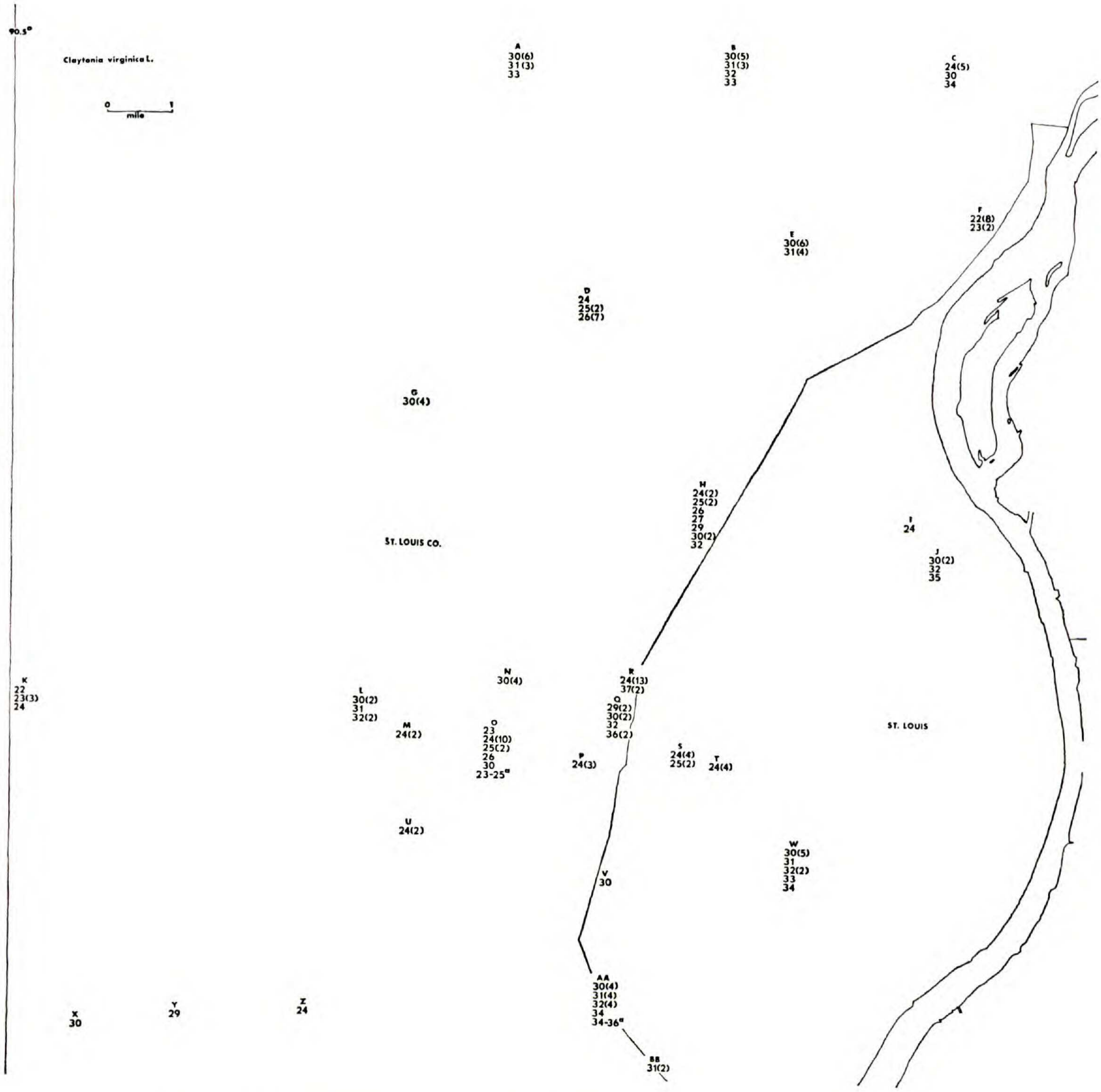

Fig. 1. Map illustrating parts of the St. Louis, Missouri area and indicating the diploid chromosome numbers of plants of *Claytonia virginica* from 28 populations (A-BB). The position of letters gives the exact locality of each population. Frequency of plants with particular chromosome numbers is given in parenthesis when more than one.

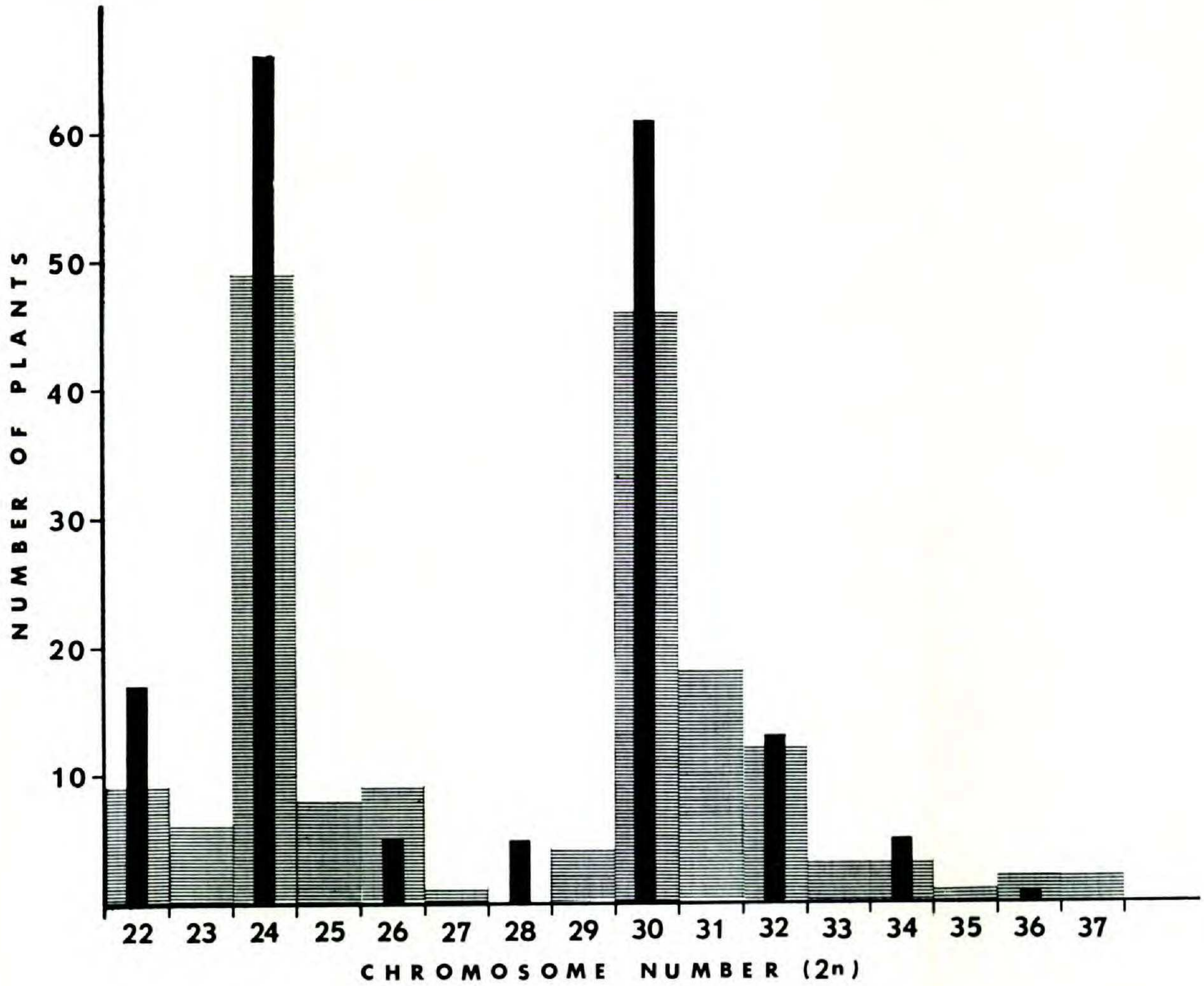

Fig. 2. Graphic representation of chromosome numbers for 173 plants of *Claytonia virgininica* examined from the St. Louis area. The wider bars indicate frequency of the total diploid chromosome number of plants, the narrower bars (solid) indicate frequency only of maximum bivalent formation converted to diploid chromosome number.

ness of plants from our area. Nevertheless a probable origin of a dominant secondary tetraploid needs exploration even if its success is of local significance only.

It may be merely coincidental that the $n = 15$ race is a multiple of the $x = 6$ line (as $5x$) or could it be possible that this seeming coincidence is related to a propensity of *C. virginica* to stabilize redundant chromosomes in multiples of six? An origin from $n = 12(4x) \times 18(6x)$ would give the necessary number of chromosomes, but the latter parent is at present very rare in the St. Louis area and in our sample no plant exhibited exclusively 18_{II} pairing. There is an alternative explanation which appears more plausible with available data. Plants with $2n = 30$, 31, and 32 are usually found together; moreover, throughout the Midwest the $2n = 32$ race is by far the most frequent (Lewis et al., 1967). Thus an origin by chromosomal loss from plants with $2n = 32$ is indicated, although, excepting the suggestion noted above, we find no reason for the high chromosomal frequency and apparent stabilization of the $2n = 30$ race in the St. Louis region.

Since most populations separated chromosomally into two groups, viz. with $2n =$ (22-)24-(27) and $2n =$ (29-)30-(37), plants in these groups were studied for possible gross morphological differences. One distinct difference was found in leaf width: those plants with $2n = 24(\pm)$ have a maximum width of $\bar{X} = 2.5(\pm 0.2)$ mm, those with $2n = 30(\pm)$ have much wider leaves with $\bar{X} = 4.9(\pm 0.3)$ mm. Four populations with plants known to have chromosome numbers of both groups proved to be intermediate in both range and grand mean width of leaves (Table 1). These plants were largely with $2n = 24(\pm)$ and the grand mean of 2.7 mm, which is much narrower than mid-point, reflects the greater proportion of lower polyploids present in the mixed populations.

Table 1. Leaf width of plants of *Claytonia virginica* grouped by populational chromosome number.

Chromosome no. (2n)	Leaf width (mm)[a]		No. of plants	No. of populations
	$\bar{X}$ ($s_{\bar{x}}$)	$\bar{X}$ range		
24[b]	2.5(±0.2)	1.6-3.9	58	10
23-37	2.7(±0.3)	2.1-3.6	22	4
30[b]	4.9(±0.3)	3.0-6.9	83	13

[a] Calculated by populational mean of maximum leaf width per plant and reported as grand mean with standard error and mean range.

[b] Predominant chromosome number of populations.

Higher polyploids, therefore, can be separated morphologically from lower polyploids in the St. Louis area on the basis of leaf width. By their narrower leaves the lower polyploids ($n = 11$-13) are similar to those found elsewhere as well as to the diploid cytotypes based on 6 and 7. On the other hand the higher polyploids ($n = 15+$) from the St. Louis area resemble the same races in other regions and these are indistinguishable by leaf width from the diploid cytotype based on 8 (Lewis et al., 1967). No other gross morphological character correlated with leaf width or chromosome number.

LITERATURE CITED

LEWIS, W. H. 1962. Aneusomaty in aneuploid populations of *Claytonia virginica*. Amer. Jour. Bot. **49**: 918-928.

———. 1967. Cytocatalytic evolution in plants. Bot Rev. **33**: 105-115, 1967.

———, R. L. OLIVER & Y. SUDA. 1967. Cytogeography of *Claytonia virginica* and its allies. Ann. Missouri Bot. Gard. **54**: 153-171.

Rothwell, N. V. 1959. Aneuploidy in *Claytonia virginica*. Amer. Jour. Bot. **46**: 353-360.

——— & J. G. Kump. 1965. Chromosome numbers in populations of *Claytonia virginica* from the New York metropolitan area. Amer. Jour. Bot. **52**: 403-407.